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PLASTICS
AS BUILDING MATERIALS

ISSUED BY THE SMALL HOMES COUNCIL

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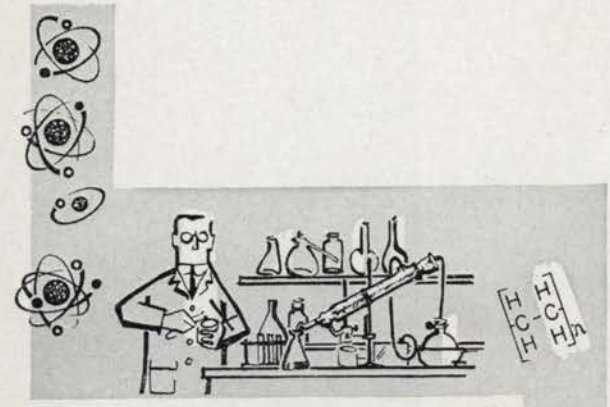
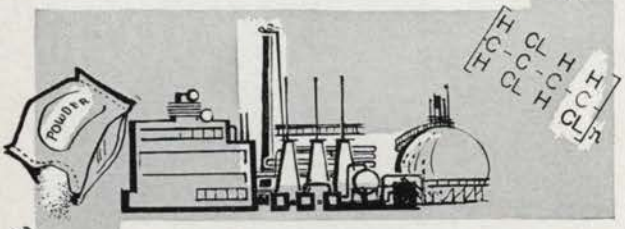
PLASTICS—BUILDING MATERIALS
SMALL HOMES COUNCIL D9.0

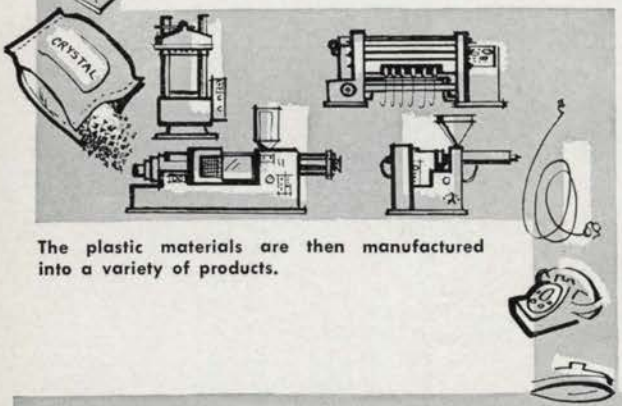
PLASTICS AS BUILDING MATERIALS



Plastics are laboratory preparations. Some of them have been known for a century or more.



Raw material suppliers produce plastics in the form of powder, pellets, granules, flakes or in semi-finished forms — rods, tubes, sheets, films or foams.



The plastic materials are then manufactured into a variety of products.

Plastics are proving themselves well-suited for many construction purposes.

These man-made materials have been used for building products in significant amounts since World War II and their importance is increasing. New plastics and new uses for them in construction are constantly being developed; processing techniques are being improved. As a result, production is greater and prices are more favorable.

The plastics include many different types or families. Each has different characteristics. As a group, however, plastics offer a combination of properties not found in other building materials. They are lightweight, tough, moldable; many of them are naturally clear.

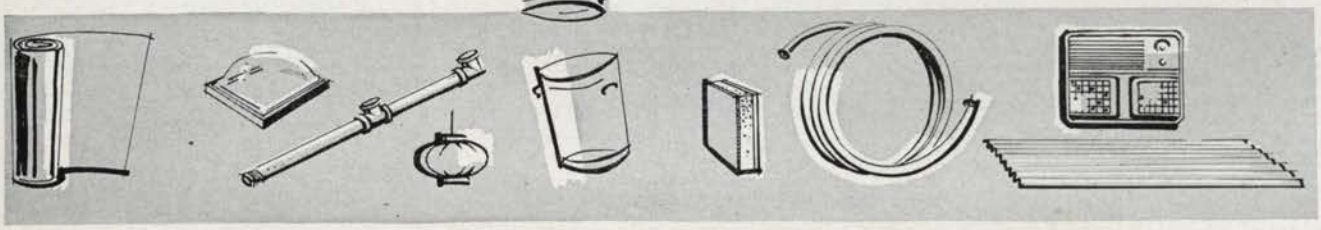
These plus other qualities peculiar to certain plastics give the building industry a new degree of design and construction freedom. For example:

- Although plastics in themselves are low in strength, they can be combined with other materials and, thus, can be made strong enough to carry structural loads. This strength plus the lightweight, toughness and moldability of plastics makes possible structural forms which in the past have not been efficient or practical — *e.g.*, sandwich-type wall panels, laminated arches, structural domes.
- The moldability of plastics indicates a strong likelihood in the future of more and more parts of the house being assembled in the factory.

Some types of plastics are more suitable for building materials than others. An understanding of the advantages and limitations of the various types is helpful in selecting plastic products and caring for them.

This circular is intended as a guide to help prospective homeowners and members of the building industry select those plastics on the market today which best serve a particular purpose in house construction. The information presented is based wherever possible on performance records, some of which include 8 to 20 years' experience with the material. In some instances, such as for weathering, the performance records do not cover as many years as do those for wood, masonry, glass, concrete and stone since the use of plastics as building materials is a relatively new development.

Sometimes plastics are used in such a way that they lose their identity — *i.e.*, in paints and adhesives. Because of space limitations, such uses are not included in this publication.



PLASTICS — What They Are

Plastics are products of the chemical industry. They contain some of the basic organic elements — carbon, oxygen, hydrogen, nitrogen.

At some stage of their processing, all plastics are soft and shapable — that is, "plastic"; hence, the name. Plastics are formed into building materials and other objects by either heat or pressure, or both.

All plastics are either *thermoplastic* or *thermosetting*. Within these two major groups are many different kinds of plastics just as there are many species within softwood and hardwood lumber.

Thermoplastic. These plastics can be softened by reheating and then reshaped. The temperature at which thermoplastics soften varies within a wide range. Many soften before they reach the boiling point of water (212° F); a few, at a temperature as low as 120° F.

Like rubber, thermoplastic materials in being reprocessed tend to deteriorate slightly with each reprocessing.

Thermosetting. Once formed, these plastics become hard and rigid. They cannot be reshaped by heating.

Most thermosetting materials can withstand heat greater than the boiling point of water (212° F); some can withstand heat up to the char point of wood.

Thermoplastic and thermosetting materials require different types of processing and manufacturing equipment.

How Plastics Are Modified

The characteristics of plastics vary considerably. Not only are there many types of plastics, but during their processing the characteristics of each type can be altered by the addition of chemicals and other materials.

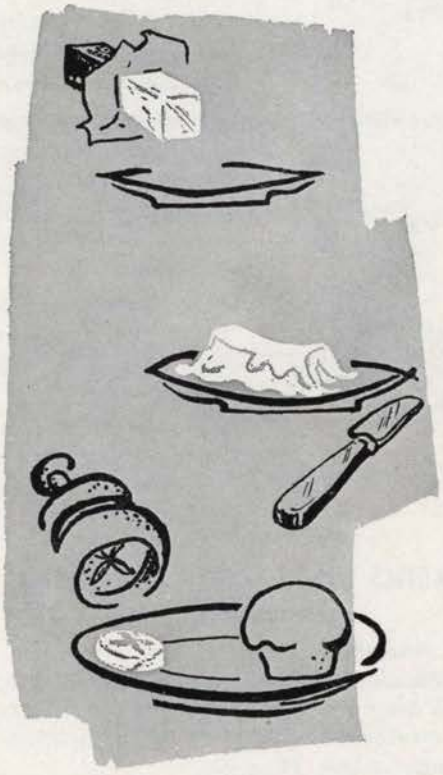
Plasticizers or softening chemicals can be added to make hard, brittle plastics more flexible or easier to mold. The ability of plastics to carry load is lessened as flexibility is gained.

Thermosetting materials are made tougher and more resistant to heat by the addition of fillers, such as glass fiber, wood flour, mica, asbestos fiber, clay, chopped fabric. As toughness is gained, the material becomes less clear.

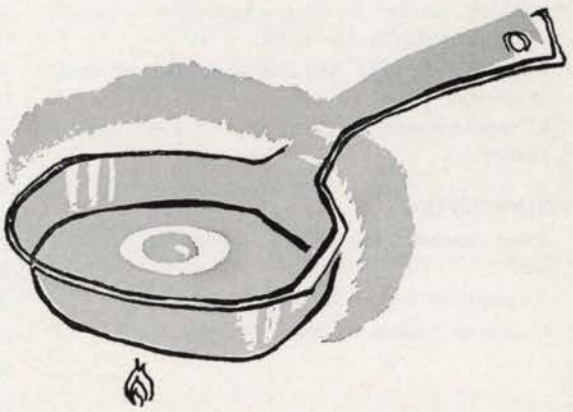
The high strength associated with some plastics is attained by adding reinforcing agents — glass (most common), wood or paper, either as sheet or fibrous materials. The chart on page 5 compares the strength of plastics with other materials.

Some plastics are foamed to make them lighter — that is, gases are mixed with the material to expand it. Such foamed materials are used for insulation and as cores for doors and sandwich wall panels.

Oxygen, carbon, hydrogen, and nitrogen are basic organic elements and are used in plastics.



The effect of heat and cold on thermoplastic materials can be compared to that on butter which can be softened and reshaped any number of times if one desires.



The effect of heat and cold on thermosetting materials can be compared to that on eggs. Once an egg is cooked — boiled, fried, poached — it can never be reverted to its fluid state.

PLASTICS COMMONLY USED FOR BUILDING MATERIALS

General characteristics of the plastics most used for building materials are summarized below. They are followed by a list of specific plastics with distinguishing qualities and limitations of each.

Over-all characteristics: Plastics are lightweight and moldable. Many of them are tough, but they can be broken if subjected to hard impact blows.

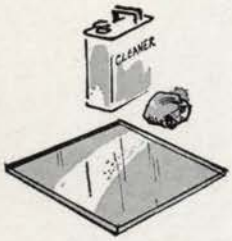
Moisture-resistance: In general, plastics absorb little or no moisture. They do not rot or mildew.

Wearability: Plastics offer a high degree of wearability and ease of maintenance for interior building purposes, such as counter tops and wall and floor coverings.

Color: Most plastics are available in a limitless range of clear, fresh colors. The purity of the colors is due to the plastics generally being colorless and transparent or translucent in their natural state. Color is added as an integral part of the material; thus, it cannot be spoiled by the removal of the surface layer.

Chemical-resistance: The resistance of plastics to chemicals depends on the chemical and its temperature. Plastics offer good resistance to corrosion.

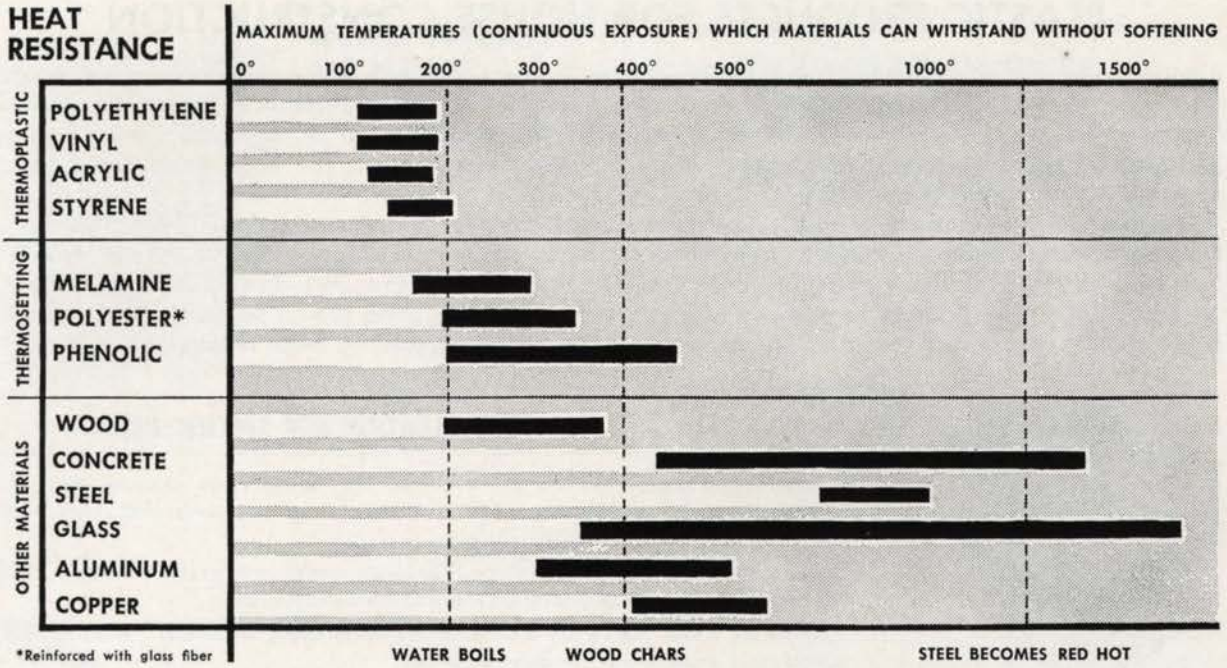
Temperature-resistance: Extreme temperatures affect the strength and dimensions of plastics. See chart on opposite page for approximate temperatures which the various plastics will withstand before softening. The amount of expansion and contraction in plastics due to heat and cold is usually greater than that for other building materials and, consequently, must be considered when used in combination with them.



Creep behavior: The amount of dimensional change in plastics under load increases as the temperature increases. The problem of creep can be minimized by designing for it. Thermosetting plastics have lower creep under load than the thermoplastics.

Fire- and electrical-resistance: Some plastics are self-extinguishing (are consumed by flame but cease to burn when the flame is removed); others burn readily. Plastics can be combined with fire-resistant materials. Plastics are good electrical insulators.

PLASTICS WHICH SOFTEN WITH HEAT (Thermoplastic)	DISTINGUISHING CHARACTERISTICS
VINYL (includes saran)	
Identification test: Burn — sample will give off bluish flame and hydrochloric acid fumes; flame will extinguish itself.	Tough. Excellent wear resistance.
Example of use: Floor tile.	Hard and rigid, but can be made soft and flexible.
Common household item: Garden hose.	Stain resistant. Self-extinguishing.
STYRENE	
Identification test: 1) Burn — sample will give off black smoke. 2) Snap with fingers — sample will give metallic-like clink.	Brittle and rigid but can be modified to become a tough and opaque material. Never available in soft, rubber-like form. Can be foamed. Available colorless or in a wide range of colors.
Examples of use: Wall tile; in foamed form, insulation.	Not recommended for continued outdoor use in clear form — becomes yellow and brittle under direct sunlight. Weatherability of pigmented styrene being tested.
Common household item: Liner for refrigerator doors.	Dimensionally stable. Slow-burning. Does not absorb water. A relatively inexpensive plastic.
POLYETHYLENE	
Identification test: 1) Feel — sample will feel waxy.	Waxy, tough, flexible to rigid. Translucent — never transparent. Lightest of the plastics — floats on water.
Example of use: Film-type vapor barrier.	Stain resistant. Does not readily absorb water.
Common household item: Squeeze bottle.	Slow-burning. Excellent electrical insulator. Not recommended for continuous outdoor use and direct exposure to sun unless specially pigmented in black for such use.
ACRYLIC	
Identification test: Burn — sample will give off blue flame and sweetish odor, and will bubble at surface. No smoke.	Hard. Rigid. Very clear. Available colorless or in a wide range of colors.
Example of use: Dome skylights.	Excellent weatherability. Slow-burning.
Common household items: Hairbrushes (backs).	



STRENGTH	LOW	MEDIUM	HIGH
	0–5,000	5,000–10,000	10,000–50,000
COMPARATIVE STRENGTH OF VARIOUS BUILDING MATERIALS Grouped according to Amount of Pull (pounds per square inch) They Can Bear without Tearing	Polyethylene	Wood Concrete Melamine Phenolic Acrylic Styrene Vinyl	Steel Copper Polyesters when reinforced Aluminum Glass (fiber)

PLASTICS WHICH CANNOT BE RESHAPED (Thermosetting)

DISTINGUISHING CHARACTERISTICS

PHENOLIC

Identification test: Burn, saw or drill — sample will give off carbolic acid odor. Sample will be difficult to ignite.

Example of use: Electrical outlets.

Common household item: Handles on electrical appliances.

Cheap, hard, opaque. Excellent durability.

Color range is limited — usually dark colors.

Withstands heat. Self-extinguishing.

Stable in dimension. Good resistance to chemicals.

AMINO : MELAMINE

Identification test: Lighted cigarette will not burn or scar it.

Example of use: Counter topping.

Common household item: Rigid-type dinnerware.

Transparent in sheet form; translucent to opaque in block form.

Wide range of colors.

Excellent durability. Hard. Not easily scratched. Resistant to water, food stains and heat.

POLYESTER (generally reinforced)

Identification test: Burn — sample will give off sooty flame.

Example of use: Translucent panels for walls, partitions, ceilings.

Common household item: Lamp shades.

High strength is achieved by addition of fibers, usually glass.

Stiff to flexible; hard to soft. (Stiff, hard types used for most building materials.)

Translucent. Good range of colors.

Good chemical resistance and weathering qualities.

PLASTIC PRODUCTS FOR HOUSE CONSTRUCTION

Among the advantages of using plastics for building materials is that each of the many plastics is different from the others — each has characteristics that make it suitable for certain products and uses. For satisfactory service, the plastic with the right properties for the intended use must be chosen; the product must be correctly designed so that it will perform adequately in its intended use; the workmanship must be of a quality to insure good performance.

Plastics and plastic products which have proven satisfactory for home construction are described here. For information regarding manufacturers of these products, write to the Manufacturing Chemists' Association, 1625 "I" Street N.W., Washington 6, D.C., or The Society of the Plastics Industry, 250 Park Avenue, New York 17, N. Y. Because new plastic products are continually being placed on the market, the list is not a complete one but represents major products commonly accepted by home builders today.

Dome

BUILDING PRODUCTS AND PLASTICS	EVALUATION FOR SPECIFIC USE

LIGHT TRANSMITTERS: Plastics are excellent for this purpose because they are lightweight and do not shatter. Their translucency is easily controlled. They offer unlimited color and light possibilities.

Plastics expand and contract more than glass under temperature changes, and this change in dimensions must be allowed for in mountings.

Plastics are softer than glass and, thus, are more easily scratched. Scratches are particularly evident on transparent sheets.

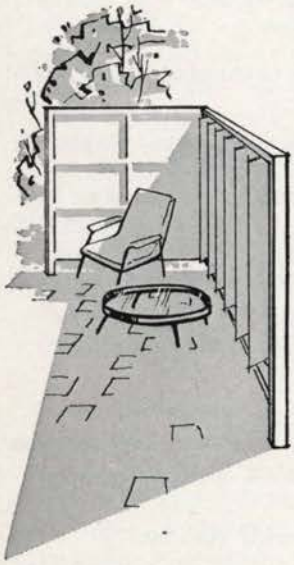
Plastics will burn if exposed to open flame. They attract dust unless destaticized.

Luminous ceilings, diffusers over individual fluorescent fixtures

Acrylic	Rates high in light transmission and diffusion. Stable in color. Available in many shapes and translucent colors. Higher in price than plastics which follow.
Styrene	Low-cost. Available in many shapes and translucent colors. Is not as stable in color as acrylic.
Vinyl	Most commonly used for luminous ceilings because it is low in cost and self-extinguishing. Durable. Extremely tough. Sheets or molded panels. Does not have the color stability of acrylic.
Polyester glass fiber	Decorative effect and strength obtained by glass fiber. Translucent. Many shapes and sizes. Self-extinguishing types available. Does not transmit quite as much light as acrylic.

Dome skylights, patio roofs

Acrylic	Transparent. Excellent weatherability. Lightweight permits easy installation. Slow-burning. Stable in color. Translucent light colors and tints are available for sun control. Available in many shapes for skylights, giving architects freedom of design: 1) flat sheet; 2) corrugated sheets; 3) molded dome shapes which are rigid, leakproof, and free from visual obstructions. Best of plastics for dome skylights. May cost more than a glass installation.
Polyester glass fiber	Strong. Available in corrugated or flat sheets which can be sawed and nailed on job; also in molded dome shapes for skylights. (See comments on domes above.) Translucent colors. Weatherability varies with exposure.



Sun control

Sun controls (including awnings), louvers

Acrylic	Good sun control. Available in solid colors and in corrugated form. Admits more light than polyesters since no fillers are used. Excellent weatherability.
Polyester glass fiber	Good performance record. Can be sawed and nailed on job.
Vinyl (coated canvas; saran)	For awnings. Strong, tough. Good weatherability and color. Stain resistant. Higher in cost than most awning fabrics.

Interior partition

Interior Partitions

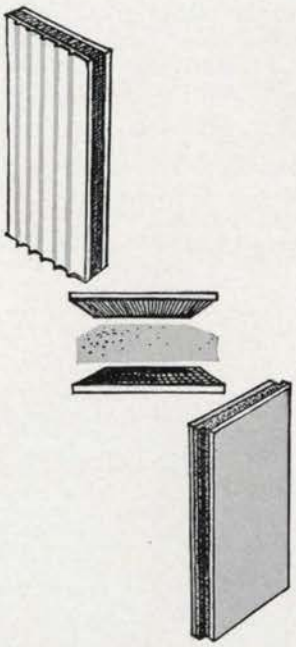
Acrylic	Light transmission is equal to clear glass. Can be obtained in smooth or corrugated sheets, colorless or tinted, patterned or plain. Since scratches show readily on transparent sheets, translucent or patterned sheets are recommended.
Polyester glass fiber	Decorative effects can be achieved. Does not transmit light as well as acrylics.

Windows

Acrylic	Use where breakage is a problem. Available in transparent, tinted, translucent or patterned materials. Scratches become evident in transparent sheets. More expensive than glass.
Polyester glass fiber	Translucent. Rates below acrylic in clarity, light transmission, and weather resistance.

Exterior curtain walls

Polyester glass fiber	Translucent. Weather resistance is fair to good, depending on exposure.



Wall panels with cores of honeycombed paper (top) and foamed plastic (bottom).

NON-LIGHT-TRANSMITTING WALLS AND ROOF PANELS: Plastics make possible lightweight, insulated, moisture-resistant panels.

Load-bearing panels for exterior and interior walls (usually sandwich)

Polyester glass fiber	Used for faces of panels having lightweight core, such as honeycombed paper or foamed plastic. Best of plastics so far for this purpose. High impact strength. Fair-to-good resistance to weather. Costly. Deflection may limit structural span.
Styrene	Used in foamed form as core of sandwich panels having wood, cement asbestos, or polyester faces. Light in weight. Good in compressive strength. Economical material.

Load-bearing roof panels

Polyester glass fiber	(See Load-Bearing Panels for Exterior Walls above.)

INSULATION AND VAPOR BARRIERS: Plastic films and foams provide effective heat and moisture barriers.

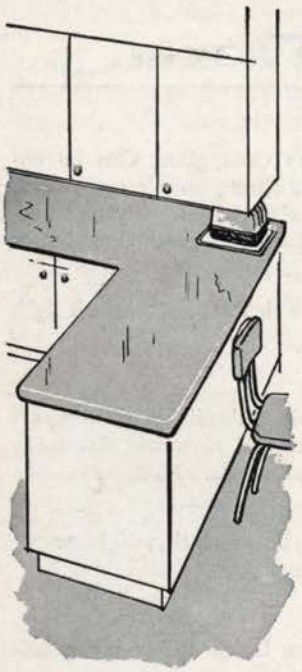
Insulation

Styrene (foamed)	Lightweight, rigid. Strong — will not crumble. Excellent resistance to water . . . does not rot or disintegrate. Resistance to heat (160° F) satisfactory. Low in cost. Especially recommended for masonry walls, perimeter insulation, roof insulation. Available in sheets or blocks in sizes which are easy to handle and to cut. Adheres readily to other materials. Slow-burning or self-extinguishing types.
Phenolic	Used as coating sprayed on glass fiber insulation. Increases rigidity of insulation.
Polyester	Used as film bonded to aluminum foil. Recommended particularly for insulation of pipes. Low water-vapor transmission rate. Highest tear strength of plastics. Jointing requires special techniques. High in cost.

Film-type vapor barrier

Vapor and moisture barriers

Polyethylene	Best of plastic vapor barriers at this time. Particularly recommended for use under slabs or in crawl spaces. Tough. Film is not affected by age, extreme temperatures or humidity. Low water-vapor transmission rate. Available in large sheets or wide rolls. Lightweight. Easily installed. Low in cost.



Counter tops and floor coverings

BUILDING PRODUCTS AND PLASTICS — EVALUATION FOR SPECIFIC USE

WEARING SURFACES: Hard surface produced by plastics is easy to maintain.

Floor Coverings*

Vinyl	Wide variety of bright, clear colors and of patterns. Easy to care for. Resistant to harsh cleaners, scuffing, staining. Will not harden with age.

Wall Coverings (plastic-coated paper or fabrics)

Vinyl	Tough. Resists marring. Easily cleaned. Broad range of colors and textures. Self-extinguishing.
Polyester	Can be used over cinder block. Not as tough as vinyl.

Wall Tile

Styrene	Good wearability for bathrooms and kitchens when set in recommended mastics. Resistant to water and chemicals. Lightweight — easy to apply. Many colors, patterns, sizes, contours. Scratches easily; do not use abrasive cleaners.

Counter Tops*

Melamine	Forms top layer of phenolic-saturated paper or cloth laminates. Durable. Good resistance to heat (382° F), but extremely hot pans should not be placed on it. Also resistant to abrasion, food stains, mild acids, alkalis, water, oil, solvents. Decorative — unlimited colors and patterns. Will not withstand knife cuts.
Polyester	Used the same as melamine, but is not as resistant to heat.
Vinyl	Vinyl is pressed on backing felt. Flexible. Many colors and patterns. Poor resistance to heat; knives cut it.

Acoustic Tile

Polyester	Used as surfacing film on phenolic-bonded fiber glass to produce an easily cleaned surface.

ELECTRICAL: Plastics are excellent insulators.

Wire insulation

Vinyl	Excellent for cords. Ages better than rubber.
Polyethylene	Excellent for television lead-in cables.

Housings

Phenolic	Durable. Stable in dimensions. Dark colors only.

Plugs, outlets, switchplates

Phenolic	Durable. Low in cost. Dark colors only.
Styrene	Low in cost. Numerous color possibilities.

MECHANICAL AND MISCELLANEOUS

Pipes

Polyethylene	Most commonly used plastic for pipes (80-90% of plastic pipes made from it). Resists rust, corrosion, chemical attack. Burns slowly. Long lengths eliminate some fittings. Does not resist high temperature and pressure. Not feasible for hot-water pipes or for installation near hot-water pipes since polyethylene softens at 120°-200°. (Pipes should withstand temperature of 250°.) Use limited to cold-water pipes and waste lines. Better fittings and valves and more performance data needed.
Vinyl (rigid)	Essentially the same advantages and disadvantages as polyethylene for household uses.

Flashing (cocoon-type), Gutters, Downspouts, Gaskets

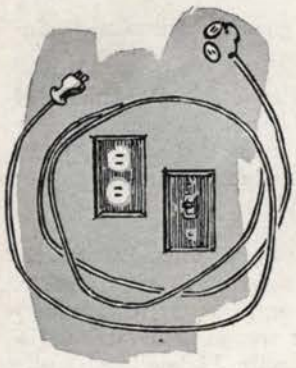
Vinyl	Good weather resistance. Self-extinguishing. Has virtually replaced rubber for exterior sealing. Dimensions change as temperature changes.

Window Frames

Phenolic (wood-filled)	Frames are made in pieces which can be easily assembled into many types of windows. Permanent colors. Good resistance to weather. Non-corrosive.

Screens

Vinyl (coated glass fiber; saran)	Good resistance to weather and chemicals. Non-rusting. Permanent colors — no need to paint. Not easily torn.



Electrical outlets

* See Small Homes Council circulars F4.6, "Flooring Materials," and F9.1, "Counter Surfaces."